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Floristic diversity in calamine areas of the Silesia-Cracow Monocline

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Abstract: The study presents results of floristic investigations conducted in areas with high concentration of heavy metals in the substrate, where zinc and lead ore deposits have been mined for many ages. Five sites were selected for a detailed investigation, located in three regions of the Silesia-Cracow Monocline. In the course of field studies, 362 vascular plant species, belonging to 73 families and 232 genera, were recorded. A group of 44 species was common for all investigated sites. Based on the analysis of vascular flora diversity in the areas under the study, it was determined that the majority of species are native hemicryptophytes. The largest proportion are thermophilic and heliophilic species of meadows and grasslands, while a large part of the flora is formed by species connected with moderately poor and mineral, and humus-rich types of soil. A noteworthy fact is the occurrence of numerous plants connected with moist and humid soils, despite the unfavorable humidity conditions. The share of halophytes and species with increased heavy metal tolerance is also conspicuous. The flora of majority of investigated abandoned mining sites includes common species characterised by extensive plasticity and numerous adaptations to the habitat conditions present in the study areas, as well as a range of species which belong to the group of protected, rare or threatened plants.

Key words: Silesia-Cracow Monocline, heavy metals, calamine plants, vascular flora, zinc-lead ore

1. Introduction

Largest deposits of zinc and lead ore in Poland are located in the Silesia-Cracow Monocline, where they have been mined and processed since the Middle Ages. On the abandoned mining terrains developed habitats with high concentration of heavy metals in the substrate. These areas are colonised by organisms which are highly tolerant to environmental stress. High content of heavy metals (zinc, lead, cadmium) in the soil contributes to the character of the habitat and therefore to the transformations of plant cover in abandoned mining areas. Unique plant communities are formed, and species with interesting biological features grow there. First floristic records from the Polish calamine area (in the vicinity of Olkusz) are contained in the studies by: Zalewski (1886), Wóycicki (1913), Pax (1918), Szafer & Zarzycki (1977) and Dobrzańska (1955). Detailed analyses of the Olkusz Ore Basin were presented by Wika and Szczypek (1990) as well as by Grodzińska *et al.* (2000).

Biologists have long been interested in vascular plant species which grow in such areas and which are rare and interesting from an ecological and physiological point of view (Wierzbicka & Potocka 2002; Baranowska-Morek & Wierzbicka 2004; Pielichowska & Wierzbicka 2004; Szarek-Łukaszewska *et al.* 2004).

The majority of calamine areas in Poland has not received a comprehensive floristic treatment until now; this is why the scarce and fragmentary data on the status and quality of calamine flora and its special character have necessitated in-depth studies.

Thus, the aim of the present study is the determination of the current species composition and the definition of the ecological characteristics of the flora with regard to special ecological habitat conditions prevailing in the selected calamine areas of the Silesia-Cracow Monocline.

2. Material and methods

The study sites are linked with the geological structure of Poland, especially with the Silesia-Cracow Monocline which is built predominantly of Triassic carbonate rock rich in zinc-lead ore deposits (Szuwarzyński 2000;

ECOLOGY

Cabała & Konstantynowicz 1999). These deposits lead to the appearance of natural aureoles of metal distribution in the environment, especially due to the shallow occurrence of ore bodies and also as a result of many ages of ore mining and processing. Oxidised zinc and lead ores are called calamines.

From the administrative point of view the study sites are located within the borders of two voivodeships in south Poland: Silesia and Małopolska. They include five areas of irregular shape which belong to different ore deposit regions, where zinc and lead ore has been mined and processed for many ages, such as: in the Siewierz-Olkusz region – the 'Bolesław' strip pit near Olkusz (B); in the Chrzanów-Jaworzno region – the 'Warpie' forest in Chrzanów Balina (W) and calamine areas in Jaworzno Długoszyn (D); in the Tarnowskie Góry-Bytom region – the study sites in the town of Tarnowskie Góry: dolomite spoil heap of the 'Fryderyk' mine (TGD) and 'Planeta' forest (TGP). The designated study areas varied in size and represented predominantly grasslands with more or less numerous shrubs as well as mixed and pine forests that are anthropogenic in character. The soil was characterised by conspicuously increased content of heavy metals (Table 1), basic pH and adverse humidity conditions.

The analysis encompassed the qualitative composition of flora and the occurrence of individual taxa depending on the diversity of biotopes in which they occurred. Data was collected as floristic lists and collections of herbarium specimens. Floristic studies were carried out in 2000-2003. Classification of species with regard to their affiliation to geographical-historical groups was based on the works of various authors (Kornaś 1968a, 1968b; Krawiecowa & Rostański 1972; Trzcińska-Tacik 1979; Zając & Zając 1996; Zając *et al.* 1999; Mirek *et al.* 2002). Analysis of calamine flora in terms of the share of Raunkiaer's life forms, ecological indicator values and phytosociological affiliation was performed following the works of Zarzycki *et al.* (2002), Rutkowski (2004) and Matuszkiewicz (2001).

3. Results

Despite the harsh habitat conditions, a total number of 362 vascular plant species, belonging to 73 families and 232 genera, were found in the study sites. The largest number of species was recorded from the sites in Jaworzno Długoszyn and Chrzanów, while the most floristically impoverished site was the area of dolomite spoil heap in Tarnowskie Góry. A group of 44 species was found to be common for all study sites, with highest floristic similarity recorded between the sites in the Chrzanów-Jaworzno region, followed by the Siewierz-Olkusz region. The second significant grouping showing considerable floristic similarity is formed by the sites located within the town of Tarnowskie Góry (Fig. 1).

The most numerously represented family in the flora of investigated areas is the family Asteraceae which constitutes between 9% and 16% of all species in individual sites, whereas in the 'Planeta' forest this family is only on the second place – after the family Poaceae which constitutes as much as 13% of the species composition of that site. On other sites, the family Poaceae consti-

Table 1. Average total content and average concentration of water-soluble metal forms in the investigated calamine sites [mg/kg d.m.]

Calamine sites	Zn		Pb		Cd	
	Total content	Concentration of water-soluble	Total content	Concentration of water-soluble	Total content	Concentration of water-soluble
'Bolesław' strip pit near Olkusz (B)	38879.0	26.0	2637.0	2.0	176.0	0.1
'Warpie' forest in Chrzanów Balina (W)	37492.0	24.0	13809.0	4.0	196.0	0.1
Calamine areas in Jaworzno Długoszyn (D)	23533.0	12.0	5370.0	2.0	263.0	0.2
Dolomite spoil heap of the 'Fryderyk' mine (TGD)	45944.0	19.0	15351.0	4.0	504.0	0.2
'Planeta' forest (TGP)	31666.0	21.0	24445.0	4.0	78.0	0.1

Explanations: B – ‚Bolesław' strip pit near Olkusz; W – ‚Warpie' forest in Chrzanów Balina; D – calamine areas in Jaworzno Długoszyn; TGD – dolomite spoil heap of the ‚Fryderyk' mine; TGP – ‚Planeta' forest

Fig. 1. Similarity of investigated sites calculated on the basis of floristic lists
Explanations: D, W, B, TGD, TGP – see Table 1

Table 2. Geographical-historical, phytosociological and ecological structure of calamine flora

Species groups	B	W	D	TGD	TGP
Geographical-historical groups	Number of species				
Apophytes	173	180	186	97	114
Archaeophytes	4	5	12	5	3
Ephemerophytes	1	5	1	0	0
Ergasiophygophytes	1	2	2	0	0
Kenophytes	7	6	8	3	0
Hybrides	0	2	2	0	0
Species with uncertain status in the Polish flora	4	2	2	0	1
Phytosociological classes	Number of species				
Molinio-Arrhenatheretea	40	38	34	25	32
Festuco-Brometea	31	24	41	18	7
Querco-Fagetea	8	26	15	6	17
Artemisietea vulgaris	20	16	14	11	5
Stellarietea mediae	7	10	15	6	5
Trifolio-Geranietea sanguinei	5	7	8	4	1
Epilobietea angustifolii	6	6	6	4	6
Species which may occur in more than one class	37	38	37	25	29
Others	40	36	45	7	17
Preferences of plants towards soil humidity	Number of species				
Very dry	3	3	4	2	0
Very dry-dry	1	1	2	0	0
Dry	33	23	43	16	11
Dry-moist	28	26	36	21	11
Moist	49	70	65	34	42
Most-humid	40	42	34	25	4
Humid	4	10	5	1	6
Humin-wet	9	4	8	1	5
Wet	4	1	1	0	2
Wet-water	0	0	0	0	1
Water	0	0	0	0	2
Broad spectrum	9	12	10	5	6

Explanations: D, W, B, TGD, TGP – see Table 1

tutes ca. 6-11% of the flora. A considerable part of the flora of calamine areas is also formed by the following families: Rosaceae (5-9%), Fabaceae (5-8%), Caryophyllaceae (4-6%), Apiaceae (4-6%), Brassicaceae (2-5%), Scrophulariaceae (2-5%) and Lamiaceae (2-5%). The remaining families which have a smaller share in the flora of investigated calamine areas add up to 26-37% of species.

Based on the analysis of vascular flora diversity in investigated sites it has been determined that species of native hemicryptophytes dominate there (Table 2). The major part is formed by thermophilic and heliophilic species of meadows and grasslands (Table 2). There is also a large proportion of species linked with moderately poor and mineral, and humus-rich soils. It is noteworthy that calamine soils, despite the unfavorable humidity conditions, harbour a high proportion of plants connected with moist and humid soils (Table 2). The share of halophytes and species with increased heavy metal tolerance is also conspicuous (Fig. 2). The flora of majority of investigated abandoned mining sites includes common species characterised by extensive plasticity and showing numerous adaptations to the habitat conditions present in the study area, thus forming a local gene repository which is useful during recultivation of terrain contaminated with heavy metals. Species of protected, rare or threatened plants appear also quite often as a result of the process of spontaneous succession on this kind of abandoned post-industrial sites (*Carlina acaulis* L., *Digitalis grandiflora* Mill., *Epipactis helleborine* (L.) Crantz, *Gentiana cruciata* L., *Malaxis monophyllos* (L.) Sw.).

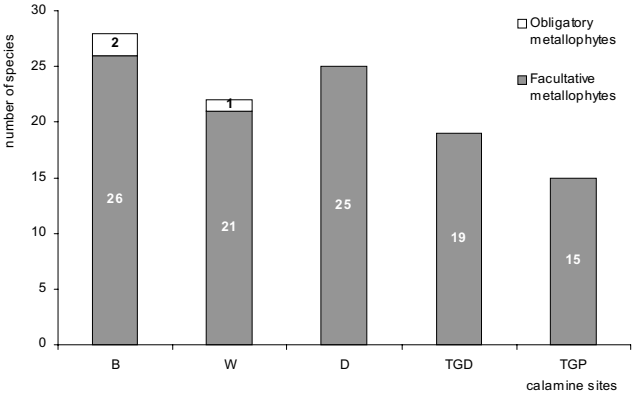

Fig. 2. Share of metallophytes in the flora of calamine areas
Explanations: D, W, B, TGD, TGP – see Table 1

4. Conclusions

The majority of plants which occur in calamine areas are very common species which are frequently found in other habitats. However, the composition of plant communities and characteristics of individual specimens are so special and distinctive that they justify the collective name 'calamine vegetation' since the sites where they occur are markedly different from other habitats.

There are many reasons for which the question of legal protection of calamine areas shall not be neglected. These areas undoubtly posses huge natural and landscape value. What is even more important is the fact that they give us unique opportunity to observe the forces of evolution creating new races and species. This process, called microevolution, is one of the best examples of evolution in action. Calamine areas preserve, without the shadow of a doubt, one of the most precious and unique part of the European calamine flora.

References

Baranowska-Morek A. & Wierzbicka M. 2004. Localization of lead in root tip of *Dianthus carthusianorum*. Acta Biol. Crac. ser. Botanica 46: 45-56.

Cabała J. & Konstantynowicz E. 1999. Charakterystyka śląsko-krakowskich złóż cynku i ołowiu oraz perspektywy eksploatacji tych rud. In: A. Jankowski (ed.). Perspektywy geologii złożowej i ekonomicznej w Polsce, pp. 76-98. Wyd. UŚ, Katowice.

Dobrzańska J. 1955. Badania florystyczno-ekologiczne nad roślinnością galmanową okolic Bolesławia i Olkusza. Acta Soc. Bot. Pol. 24: 357-408.

Grodzińska K., Korzeniak U., Szarek-Łukaszewska G. & Godzik G. 2000. Colonization of zinc mine spoils in southern Poland – preliminary studies on vegetation, seed rain and seed bank. Fragm. Flor. Geobot. 45(1-2): 123-145.

Kornaś J. 1968a. Geograficzno-historyczna klasyfikacja roślin synantropijnych w Polsce. Mater. Zakł. Fitosoc. Stos. UW Warszawa-Białowieża 25: 33-41.

Kornaś J. 1968b. Prowizoryczna lista nowszych przybyszów synantropijnych (kenofitów) zadomowionych w Polsce. Mater. Zakł. Fitosoc. Stos. UW Warszawa-Białowieża 25: 43-53.

Krawiecowa A. & Rostański K. 1972. Projekt usprawnienia klasyfikacji roślin synantropijnych. Phytocoenosis 1(3): 217-222.

Matuszkiewicz W. 2001. Przewodnik do oznaczania zbiorowisk roślinnych Polski. In: J. B. Faliński (ed.). Vademecum Geobotanicum 3, 537 pp. Wyd. Nauk. PWN, Warszawa.

Mirek Z., Piękoś-Mirkowa H., Zając A. & Zając M. 2002. Flowering plants and pteridophytes of Poland. A checklist. In: Z. Mirek (ed.). Biodiversity of Poland 1,442 pp. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Pax F. 1918. Die Pflanzenwelt Polens. 134 pp. De. Reimer Verl. Berlin.

Pielichowska M. & Wierzbicka M. 2004. Uptake and localization of cadmium by *Biscutella laevigata*, a cadmium hyperaccumulator. Acta Biol. Crac. ser. Botanica 46: 57-63.

Rutkowski L. 2004. Klucz do oznaczania roślin naczyniowych Polski niżowej. Wyd. II, popr. i unowocześnione, 814 pp. Wyd. Nauk. PWN, Warszawa.

Szafer W. & Zarzycki K. (eds.). 1977. Szata roślinna Polski, I, wyd. 3, pp. 615. PWN, Warszawa.

Szarek-Łikaszewska G., Słysz A. & Wierzbicka M. 2004. Response of *Armeria maritima* (Mill.) Willd. to Cd, Zn, Pb. Acta Biol. Crac. ser. Botanica 46: 19-24.

Szuwarzyński M. 2000. Zakłady Górnicze 'Trzebionka'S.A. 1950-2000. 100 pp. Wyd. Przedsiębiorstwo Doradztwa Technicznego 'Kadra', Trzebinia.

Trzcińska-Tacik H. 1979. Flora synantropijna Krakowa. Rozpr. habil. UJ 32: 1-278. Kraków.

Wierzbicka M. & Potocka A. 2002. Lead tolerance in plants growing on dry and most soils. Acta Biol. Crac. ser. Botanica 44: 21-28.

Wika S. & Szczypek T. 1990. Szata roślinna Olkuskiego Okręgu Rudnego. Zeszyty Nauk. AGH im. S. Staszica Nr 1368, Sozologia i Sozotechnika 32: 163-181.

Wóycicki Z. 1913. Obrazy roślinności Królestwa Polskiego. IV. Roślinność terenów galmanowych Bolesławia i Olkusza. 34 pp. Kasa Mianowskiego, Warszawa.

Zając A., Zając M. & Tokarska-Guzik B. 1998. Kenophytes in the flora of Poland: list, status and origin. In: J. B. Faliński, W. Adamowski & B. Jackowiak (eds.). Synantropization of plant cover in new Polish research. Phytocoenosis 10 (N.S.) Suppl. Cartogr. Geobot. 9: 107-116.

Zając M. & Zając A. 1996. Archeophytes in Poland. Origin and recognition criteria. In: S. Mochnacki & A. Terpó (eds.) Anthropization and the Environment of Rural Settlements Flora and Vegetation, pp. 14-26. Preedings of International Conference. Tarkal-Tokaj, 24-28.07.1996, Košice.

Zalewski A. 1886. Zapiski roślinoznawcze z Królestwa Polskiego i z Karpat. Sprawozd. Komisji Fizjogr. Akad. Um. 20: 171-190.

Zarzycki K., Trzcińska-Tacik H., Różański W., Szeląg Z., Wołek J. & Korzeniak U. 2002. Ecological indicator values of vascular plants of Poland. In: Z. Mirek (ed.). Biodiversity of Poland 2, 183 pp. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.